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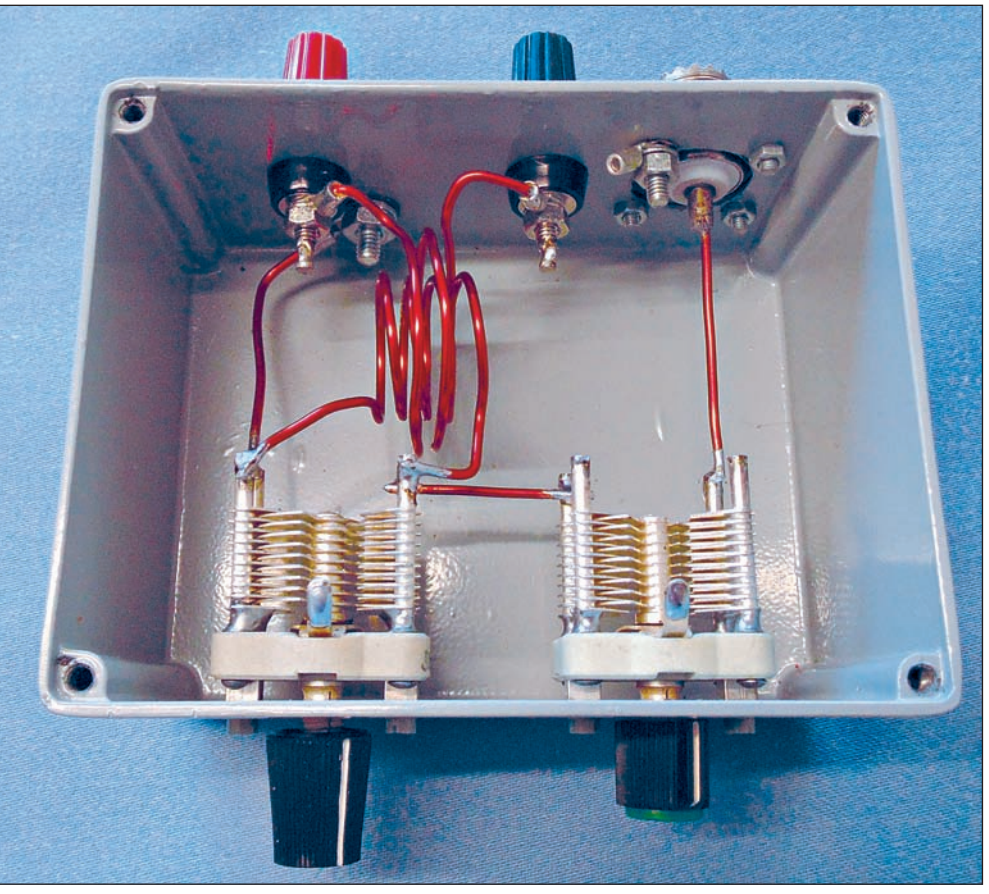
A Simple Antenna Matching Unit for VHF

John Adams G3ZSE describes a handy matching unit for the VHF bands, allowing you to make contacts without having a resonant antenna.



A view inside the ATU.

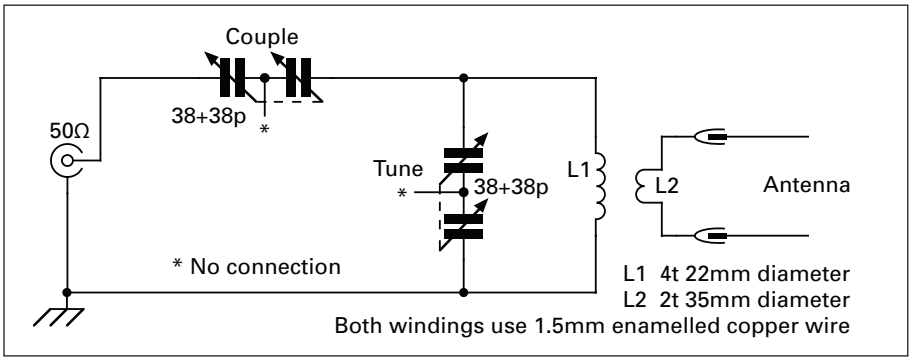


Fig. 1: The circuit diagram of the unit.

At VHF (6, 4 & 2m), it is normal to have an antenna with a 50Ω feedpoint and it is generally easy to arrange this. However, there are times when I have found it useful to have a means of matching an antenna to a transceiver, either to try a new band or when a favoured antenna is undergoing some maintenance. For example, you may have an Icom IC-7100 and want to try 4m without wanting to put up a dedicated 4m antenna. The unit I describe here will match a variety of antennas for 6 and 4m.

An Outline Specification

I decided that this unit should work with100W of SSB, have a reasonable bandwidth (to avoid retuning when moving, say, ±250kHz) and have reasonable efficiency with low losses (especially in the coils).

A Little Bit About Tuning and Matching

I know there are often debates about the differences between an antenna tuning unit (ATU) and an antenna matching unit (AMU). I usually refer to all such units as ATUs or tuners. However, my opinion in this case is that what I describe is actually a matching unit. It will match the complex impedance of the (generally) non-resonant antenna in use to the 50Ω transceiver output. There will be some loss of power in this matching unit and there will be some loss in the antenna feeder. This may be higher than you think because the feeder will be unmatched to the non-50Ω antenna. That said, remember that here we are likely to be attempting to use antennas outside their design frequencies to get some useful signal out!

The Z-Match in General

The Z-Match unit dates back a long way and became popular for HF use in the UK in the 1960s and 70s, especially with the one made by KW Electronics. My own first real experience of a Z-Match came with building the HF version from the RSGB *Radio Communication Handbook* in the

The front panel.

Rear view.

1980s. I found that it worked extremely well with a G5RV antenna and I use it still, despite having acquired two commercial Z-Match units (they look much nicer but mine has lower losses!). With all Z-Match units, it is advisable to find the two control settings on low power first. The Z-Match is connected between your SWR meter (or transceiver, if you are using a built-in SWR indicator) and the antenna. Start by setting the capacitors to mid-way and then use the Tune capacitor to find the minimum SWR. Adjust the Couple capacitor slightly and Tune again. Keep adjusting the two capacitors alternately until you find a point of minimum SWR, usually near to 1.0:1, with the Couple as high a capacitance as possible, that is to say, as meshed as possible. The diagram, **Fig. 1** shows this well-proven circuit.

The Design

I took an experimental approach to the design, looking at the components in my three HF units. The critical components are the two linked coils and, basically, I scaled these down from the HF ones, using the ratios of the frequencies involved. I then did some checks using standard inductance formulas for coils. The coils are made from 1.5mm diameter enamelled copper wire. Two capacitors are needed. I would like to recommend a suitable source for these but I have not found a UK one. I frequently need variable capacitors and they are still plentiful at rallies and on eBay (at rallies, it can sometimes be cheaper to buy an item of gear and extract the capacitors from it). The capacitors need to handle the voltages found at 100W at unknown impedances and I have found a minimum spacing of 1mm between plates on the rotor to be adequate although larger spacing can be used. Split-stator types are to be preferred because then the RF current is not passing through the lossy rotor contact – again, see Fig. 1. Also, note that using the two stator sections of the capacitor puts these in series and halves the capacitance. For my particular capacitors, each 38+38pF capacitor becomes a single 19pF capacitor. In theory, much higher value capacitors could be used but if too high, then the residual stray capacitance may be too much for this VHF circuit.

Construction

I used a diecast metal box as shown in the photographs but any reasonable metal box will suffice. My box is 119 x 89 x 55mm. The size used will depend on the physical size and mounting arrangements of the capacitors. I chose to use 4mm binding post terminals for the output so it would be simple to connect to a balanced 450Ω feeder from a G5RV antenna. I use a short cable that has a PL259 at one end and spade terminals at the other, for when I want to use the unit with coaxial feeds. You may want to fit an SO239 output as well as, or instead of, the 4mm terminals. Fit the capacitors and input and output connectors into the box, along with a simple ground terminal. Ensure that none of the metalwork of the capacitors is touching or too near to the metal box. You may need, as I did, to use nylon screws to mount the capacitors. Next, wind the coils, noting that these are self-supporting with the tuned coil sitting inside the output coil. This needs a little working out and it is best to have quite long tails on the coils and to trim these down as the fitting process progresses. Try to keep as close to the given diameters as possible. I used a large marker pen and a plastic bottle top to form the windings. Various knobs can be used but do make sure that any grub screws are recessed and will not touch your hand during use. Note that the box is also ground/earth. It is essential to make good quality solder joints between the parts. Use the same 1.5mm wire for the interconnections between components. Don't use thinner wire for the coils or connections or the RF losses will be too high.

Parts list

1 x metal box – see text

2 x knobs

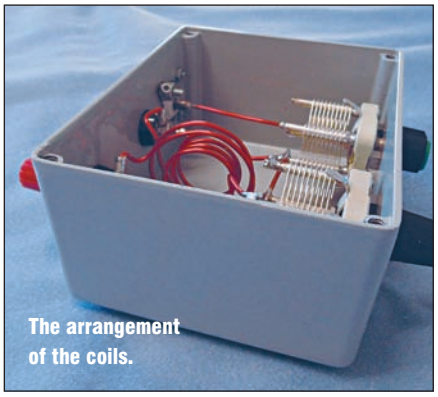
2 x spit-stator capacitors, around 38+38pF each

85cm of 1.5mm diameter enamelled copper wire

1 x SO239 socket

2 x 4mm terminals

Various nuts, screws and washers



The arrangement of the coils.

Testing

Firstly, when testing, be aware that you have semi-exposed RF terminals and only make connections with the transceiver off. The first test should be at low power with a 50Ω dummy load, to ensure that the unit is fundamentally sound. You can also check that after feeding continuous carrier power through the unit and into the dummy load, the casing above the coils does not get warm. My own tests, using small car bulbs for comparison, indicated that the loss at 100W on the 6m band was probably around 5W. I carried out tests on 6 and 4m using a G5RV antenna and on 4m using two a 2m halo and a 2m dipole. All matched easily and well to 1:1 SWR. The G5RV gave surprisingly good results on both bands. On 6m, it was possible to cover about 1MHz without retuning.

Conclusion

Construction is straightforward and this matching unit will be handy to have in the shack. It will allow experimentation with non-ideal antennas at 6 and 4m.